No. 2.] [NOVEMBER, 1876.

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

Mineralogical Society

OF

GREAT BRITAIN & IRELAND

INSTITUTED 3rd FEBRUARY, 1876.

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THE MINERALOGICAL SOCIETY

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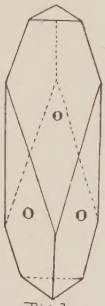

Fig 1.

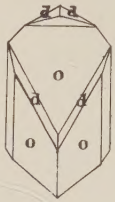

Fig. 2.

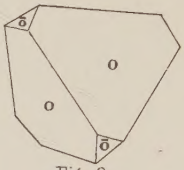

Fig. 3.

Fig. 4.

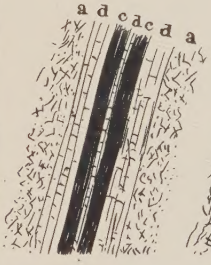

Fig. 5.

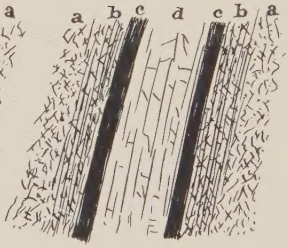

Fig. 6.

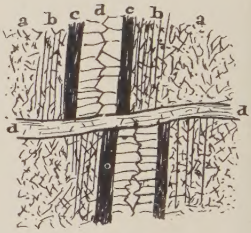

Fig. 7.

Fig. 8. × 150.

Fig. 9. × 150.

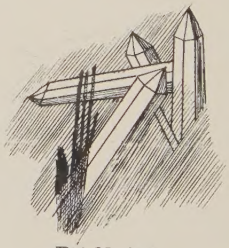

Fig. 10. Nat. Size.

Lake & Lake, Truro.

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EXCERPT MINUTES OF COUNCIL MEETING,

Held at Glasgow University, on Wednesday, September 6th, 1876,

Prof. M. Forster Heddle, F.R.S.E., *Vice-President,* in the chair.

Resolved—That the following gentlemen having been duly proposed in accordance with Rule V. be elected, viz:

MEMBERS.

Prof. Archibald Liversidge, University of Sydney, New South Wales.
Mr. Richard Taylor, F.G.S., 6, Queen Street Place, London, E.C.
Mr. Arthur Taylor, F.C.S., Pontgibaud, Puy de Dome, France.
Mr. Jos. Jewell, 22, Pool Street, Carnarvon.

ASSOCIATE.

Mr. E. F. Morton, Liverpool.

GENERAL MEETING

Held at Glasgow University, on Wednesday, September 6th, at 3 p.m.

Prof. M. Forster Heddle, F.R.S.E., *Vice-President,* in the chair.

The Chairman gave an address on "Scotch Minerals, the how and where to find them.

The following papers were read:—

1. On the critical point in the consolidation of granitic rocks, by H. C. Sorby, F.R.S.

2. Remarks on the *Principle of least paste* as regulating the crystallization of fixed rocks, by Prof. Haughton, F.R.S.

3. Notes on a mineral from New South Wales, presumed to be Laumontite, by Prof. Liversidge, F.G.S.

4. Some notes from an old catalogue of Minerals, by Prof. A. H. Church, F.C.S.

5. On the occurrence of Achroite at Rock Hill, in the parish of St. Austell, Cornwall; and on the black tourmaline of the same locality, by J. H. Collins, F.G.S.

Mr. Patrick Dudgeon, F.R.S.E., exhibited a large series of new or rare Minerals and rock-specimens, which he and Prof. Heddle had collected in Scotland, including 20 species of Minerals new to Britain, of which 6 or 7 were new to Science.

Mr. J. H. Collins, F.G.S., exhibited specimens of Henwoodite, and Enysite; also specimens of Achroite and Schorl Rock, in illustration of his paper.

Mr. A. K. Barnett, F.G.S., Penzance, exhibited a series of specimens of Henwoodite, shewing the gradual change of the mineral on the exterior to a bright green color.

Mr. C. O. Groom Napier, F.G.S., exhibited some magnificent fibres of Asbestos from Monte Rosa. Some of these fibres were upwards of two feet in length, but Mr. Napier stated that fibres of 5 yards long had been obtained from the same locality. They occur under the ice, the more flexible fibres at the greatest elevation.

The thanks of the meeting, which was composed of a large number of members and their friends, were voted to Prof. Young, M.D., for his courtesy in granting the use of the meeting room.

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1.—*Address on "The how and the where to collect minerals in Scotland."*

By Professor M. Forster Heddle, M.D., F.R.S.E., &c., Vice-President.

Delivered at Glasgow, Sept. 6, 1876.

PROFESSOR HEDDLE remarked that this title would sound strangely to southern ears; as in England and probably also in Ireland, the putting money enough in the pocket, and proceeding to the shop of a dealer, was the ordinary, and indeed the all sufficient method; though some enthusiastic collectors might go so far as to visit the openings of mines; while some adventurous ones might even explore them. In Scotland no such method of procedure could be adopted; there were absolutely no mineral dealers now in Scotland; there were almost no mines, and of these none now yielded minerals of special interest.

He would not say that it was not here quite as necessary to put money in the pocket, but the collector must in all other respects depend on his own individual exertion: he must search for and extract the specimens from the including or enclosing rock himself.

Before proceeding on such a search, at least if the search was to be original, it was all important that he should learn the geology of the district; not necessarily as taught in books, but as taught by the rocks.

The experience of some five and twenty summers devoted to such exploration, in many districts of Scotland, enabled Professor Heddle to indicate the following situations as the chief localities in which minerals might be hoped for.

1st.—*Junctions of formations and of strata—at least among metamorphic rocks.* It was to be expected that metamorphic action, by stimulating chemical affinities, would induce the formation of a greater number of minerals where two rocks of different composition came in contact, than would be found in the general mass of either.

2nd.—*At or near the point of contact of injected dykes or igneous masses*: And for reasons very similar to the above. There was here more active, though more local metamorphism; from direct heat acting in conjunction with the insinuation of a material of a nature different from that of the penetrated rock.

3rd.—*At escarpments, faults, shore cliffs, and hill-tops.* In these situations we have the advantage of searching the rock in section,—more or less through its mass as it were; just as if we were directly cutting into it by quarry or railway excavation. And such localities lead one to reflect on the vast expenditure of force, artificial or natural, which a single mineral specimen represents:—of rending force of gunpowder, or breaching force of sea wave, or elevating force of earthquake throe.

The mineralogist is placed at a great disadvantage as compared with his brethren of other departments of natural history. The botanist, the entomologist, the zoologist, find the objects of their regard on the surface, almost ready to their hand; the conchologist and marine zoologist, perhaps the most unfavourably situated among them, have merely to drag a dredge over the sea bottom; but the carrying of ponderous hammers up steep hill sides, in the mere hope of a find, is a favourable presentation of what the practical mineralogist has to do, before he begins his work.

4th.—*The amygdaloidal beds of igneous rocks of tertiary age, and chiefly the upper surfaces of these beds.*

5th.—*The junctions of limestone strata with rocks of metamorphic age.*

The last of the above localities Professor Heddle regarded as being, in Scotland, the most richly mineral-bearing of the whole; and, as he saw that the list of papers to be submitted to the meet-

ing was a full one, Professor Heddle intended to confine himself to a consideration of the causes of the fruitfulness of the last enumerated locality.

He had frequently observed that limestone strata in the metamorphic rocks of the Highlands of Scotland seemed to function as igneous rocks, in the changes they induced or seemed to induce in the including rock; but this special mode of functioning, at first sight very anomalous as regarded a substance and structure of unquestionable organic origin, was only to be observed in certain circumstances.

If the limestone bed was thin, whether disturbed or undisturbed, convoluted or not so, there was no change. The stratum itself was still *limestone*, a more or less impalpable paste—amorphous in its nature—structureless; or if with recognisible structure, then it was that of an imbedded and badly developed organism. Here the including rock showed no greater amount of metamorphism in the vicinity of the lime than elsewhere; while, in neither lime nor including rock were there to be found any minerals, other than the ordinary ingredients of their general mass. And all this also holds with equal force in the circumstances of the lime stratum being of considerable extent, so long as it be untroubled,—unconvoluted.

But it is not so if the stratum be at one and the same time large in mass, and highly contorted. Then, the calcareous mass no longer is amorphous in its substance, and organic in its structure; it presents itself as a *granular limestone*, often as a true marble; that is, it is *calcite*, and is crystalline in structure, and in all its inherent properties. Again, the including rock is, in the immediate vicinity, much more highly metamorphosed than it is throughout its general mass. While lastly, imbedded in the limestone, and to a smaller extent in the altered rock, but in both cases near their point of contact, there are found numerous minerals, *all* of which are such as can be formed by the union of the constituents of the inclosed limestone with the inclosing gneiss.

The assigning of the above local changes to the mere presence of limestone in a rock which is undergoing ordinary metamorphic change, will not suffice as an explanation of what is found in the above case. Ordinary metamorphic change is, in our almost total ignorance of the subject, usually assigned to hydrothermal action (how excited?) at great depths, *i.e.*, under enormous pressure. Such a thermal change

should affect a plicated and a nonplicated included rock alike; and should certainly affect a thin bed of lime more than a thick. As the result of any change thus passing from *without inwards*, that is from the gneiss to the limestone, we should expect to find the thinner parts of the stratum of the latter wholly converted into large granular marble, and very fully pervaded with mineral species; while the thicker masses of the lime should be much less altered in both respects: but this is the opposite of what obtains; and so any explanation which requires that the agent of change should act from *without inwards* does not suffice.

The whole facts of the case seem to point to an action taking place from *within outwards*. So at least is it to be seen how there should be greater change where the stratum is thickest; the greater the mass the greater must be the amount of action, if that action proceed from within.

But what action, physical or chemical, can be conceived to take place within, or emanate from a sedimented, amorphous, organic limestone, which shall credit it with being at one and the same time the agent of its own metamorphosis into its crystalline allomorph,—of augmenting the metamorphosis of a rock in its immediate neighbourhood,—and of stimulating to the chemical union of the material of its own mass with the constituents of that rock?

Among the physical agencies which induce a change from the amorphous or colloidal to the structural or crystalloidal condition, we find *plication* and *heat*. Sir James Hall's experiments have shewn that direct heat under pressure will change limestone into marble or calcite; and *plication*, in the very act of transforming a colloid into a crystalloid, does so at the cost, so to speak, of an elimination of heat from the substance so plicated. Melt lead, pour it out on a flat stone,—in cooling it assumes the structureless amorphous form, with rounded colloidal outline; if, after cooling, it is bent in the hand, it gives out heat, becomes crystalline in structure, gradually loses its pliability, and assumes the brittleness inseparable from the crystalloidal state,—the same holds for iron and all metals capable of assuming the colloidal state; bend or beat them, they give out heat, becoming crystalline and brittle in the so doing.

The heat here eliminated is an outcome of the change from the colloidal to the crystalloidal condition; the agent of the elimination was the plication to which the substance was subjected,

which plication was at the same time the immediate agent of the physical transformation.

Professor Heddle then suggested that it might come to be found that *the specific heat of substances in their colloidal state was always greater than that of their crystalloidal.* He was not aware that the attention of physicists had been directed to this point; nor was he aware that any researches had been made specially to determine it.

The following table, embodying all he had been able to find, seemed clearly to bear out such a view:—

Colloid.		Crystalloid.	
Water	1·	Ice	·72
Lamp Black	·260	Graphite	·201
		Diamond	·174
Limestone and chalk ..	·264	Calcite and marble ..	·201
Chalcedony	·195	Quartz	·179
Titanic acid (artificial)	·172	Rutile	·163
Peroxide of iron (artificial)	·176	Hematite	·166

Should it prove to be the case that the amorphous form had a specific heat always exceeding the crystalline, a step probably would be gained in the explanation of metamorphism generally: it might at least be held that the high specific heat of limestone, and the much lower heat of calcite or granular marbles, explained the local metamorphism which he was now considering; as the plication, crushing and folding of the strata, *expressed or extricated as heat of active energy* the difference in the amount of the specific heats of carbonate of lime in its two states,—the excess which was special to it in the colloidal. This expressed heat left only a residue, so to speak, sufficient for granular limestone; while it became the active agent in stimulating the chemical affinities existing between lime and the silica, alumina, and alkalies of the gneissose matrix. It thus led directly to the formation of minerals, while it is at the same time expedited or perfected a more through metamorphosis—i.e., the assumptiou of a more perfectly developed crystalline structure,—in the previously only partially metamorphosed rock.

The assumption of a definite crystalline structure,—a character or property directly attached to a definite chemical composition,—must of necessity extrude from the resultant calcite the phosphate of lime and fluoride of calcium which limestones contain, uniformly

distributed throughout their mass. *Apatite* and *fluor spar* are accordingly among the crystallised minerals found imbedded in the saccharoid "primary" limestones.

Whether the extruded heat can actually fuse the residual calcite may yet be ascertained by direct experiment; but it would seem to be almost a necessary deduction, that no mineral could be formed by such an action, possessed of or requiring a specific heat greater than that of the original source of the expressed heat.

It must be borne in mind that chemical elements do not alone go to the formation of any substance;—a due amount of certain physical agencies is the special portion of each, lodging in their pores as resting places;—of the chemical ingredients one alone may suffice; of the physical—among which heat, phosphorescence and magnetism may be said to be those most germain to minerals—heat is the only one which is never absent. Chemical Affinity then can only *predispose* to the union of the constituents which go to form the substance; for something more is requisite before the formation can be accomplished—before the substance, can, so to say, assume an independent existence,—namely the supply of the heat special to it —to the perfect putting together of the whole as a mineral species.

It has, however, to be admitted that we are unable, positively, to affirm that the expressed heat may not be so concentrated in the spots where the chemical action is operating as to afford any specific heat required.

Two arguments against such a view may be, however, adduced;—the first, that the heat extricated throughout the general mass would not readily be localised or carried specially to any point in so badly conducting a substance as granular limestone or marble; —more probably would it accumulate within the limestone itself, even to the point of its fusion: and, indeed, the occurrence of porphyritically disposed crystals of quartz with rounded angles, throughout the general mass of some marbles, would seem to indicate actual fusion.

The second—that it has not yet been shown that there is the necessity for such concentration.

The high specific heat of the matrix is, in the present case at least, amply sufficient; no one of the minerals found in the above localities possessing so large an amount of heat as ·264—that of limestone.

That of the following is known:—

Fluor	·19
Apatite	·170
Tetrahedrite	·192
Actynolite	·204
Augite	·194
Diopside	·190
Pyrrhotite	·16
Molybdenite	·102

It is a somewhat significant fact that *limestone has a specific heat superior to that of any other rock mass;* we speak of mollusks and crustaceans as "cold blooded,"—though it is believed that they have a temperature somewhat higher than that of the medium in which they live;—but the calcareous matter which they have secreted from solution in that medium, for the defence of their soft parts, is deposited and arranged with an organic and noncrystalline structure, and consequently has had conferred upon it the high specific heat of the amorphous state; and so the long buried skeletons of these organisms are abiding store-houses of heat, until called upon to yield up their surplus store and thus become the active agents of future change.

A brief sketch may now be appended of the localities in Scotland where limestones of the age referred to above occur.

Although there are many localities where metamorphic rocks contain calcareous beds, yet their continuity and connections can nowhere so easily be made out as in the counties of Banff, Aberdeen, and the north of Perth. In this district the general trend of the outcrop is from N.N E. to S.S.W.; the dip, usually at a high angle, being to the E.S.E. The lowest member of the series which includes calcareous beds is an argillaceous mica-schist; this is succeeded to the east by a highly metamorphosed quartzite of a pinkish tint; the dip of which is somewhat more southerly than that normal to the series. Eastward of the quartzite the characteristic "gnarled gneiss" of Scotland supervenes, rolling over the country in repeated folds; convoluted and contorted in the extreme. This gneiss is composed of orthoclase of a somewhat bluish tint, passing occasionally to cream colour, and containing over half a per cent. of lime; a black or bronzy mica, which will probably prove to be lepidomelane, and pale blue quartz, quite subsidiary in amount. This rock, highly character-

istic from the manner in which its dark micaceous layers display the marvellous plications into which it has been crumpled, dominates throughout the county of Aberdeen to a far greater extent than the granite-blotched geological maps admit: and it is a question, to be determined perhaps not so much by the labours of the officials of the Geological Survey, as by work special to this Society, whether, the granitic masses represented by these blotches, be not the completed result of the action of the same agencies which produced the intermediate stage of gnarled gneiss.

In no place, perhaps, can the gneiss be shown actually to abut upon the quartzite, for there intervenes a bed or a series of beds of limestone, associated for the most part with serpentine; and associated also throughout a district of the country, in which there would appear to be a bifurcation of the series, with a mass of rock usually assigned to the plutonic division of the igneous rocks, and the basic section of that division.

It has been stated above that the dip of the quartzite was not absolutely conformable to that of the mica slate; the relations of this quartzite have yet to be thoroughly investigated: probably it will prove to be the lowest member of the series; it is in the north somewhat talcaceous, and micaceous in its southern reaches. Such being the general relationships of the rocks, their geographical position has now to be pointed out.

The argillaceous mica schist is first seen in the north, a few miles south of Cullen in Banffshire, stretching thence to the S.W. it occupies the whole of the low ground of the Vale of Deskford, Glen Isla, Glen Rinnes, Glen Livat, the braes of Abernethy, and the upper reaches of Strath Alnack; and the lower part of these hollows is occupied by a frequently interrupted but on the whole very persistent bed of limestone. The general character of both schist and limestone being an absence of disturbance, trouble, folding, or dislocation of their beds.

Of the quartzite little need be be said: a considerable though detached mass of it appears in the neighbourhood of Cullen: the portion supposed to overlie the argillaceous schist of the western valley, commences in the Durn hill, south of Portsoy, and stretches in two parallel ranges of highly elevated land, protruding as it were through the sea of micaceous mud which lies at their feet, with but few breaks in the continuity of their course, till, converging after forming the buttressed walls of Glen Clunic,

they constitute the great mass of Ben Uran and Ben y Gloë :— reappearing in small amount here and again, and being finally denuded off, after forming the terminal fifty feet of the sharp summit of Aonach Beg near Loch Ousan.

Immediately above the quartzite there comes in a series of beds of serpentine of at least three varieties, alternating with beds of limestone ; the thinner beds of the latter of so trifling and inconstant a character, as to lead to the suspicion that they may not be sedimentary limestones at all ; but be due to a metamorphism of the diallage rock, which, by the action of carbonated waters, was transmuted into beds of serpentine and calcite. These beds of serpentine all show themselves in the north in the neighbourhood of Portsoy in Banffshire ; they hold a parallel, or perhaps a united course as far as the head of the Blackwater in the same county, where they appear to separate or trifurcate : one, which continues to hug the quartzite, according to McCulloch, is seen in the Ey Forest, and probably loses itself in the serpentinous marble of Glen Tilt : another, seen on the Kindy, the north-east shoulders of Culbleen, the Coyle, and Little Kilrannock, is lost among the cliffs of the Canlochan of Glen Isla : while the third, associated almost throughout with gabbro and true syenite, crosses the Alt Devoran, forms the hill of Tombreck or Towanrieff, re-appears at Knockespock, Chapeltown, Premnay, Barra Hill, and Belhelvie, passing five miles north of Aberdeen into the German Ocean at the Schiller-spar of the Black Dog Rock.

Throughout the whole of this extended reach the serpentine is so commonly associated with limestone, that where they do not appear in company, they may be mutually said to represent each other ; all, more or less included in the gneissose rocks, share the vicissitudes of dip, strike, and plication to which the including rock has been subjected ; and these limestones offer a marked contrast in almost every respect to the undisturbed and comparatively barren bed first mentioned as occurring in the argillaceous sandstone.

It is in those portions of the limestone beds which are not associated with serpentine, but which lie among the most highly plicated, disturbed, and fractured strata, that the largest number and the largest amount of mineral bodies are found. Doubtless, the fact of one stratum having an argillaceous, and the other a gneissose matrix, cannot be without influence ; but the absence of minerals in the gneissose beds, when these are either small in quantity or unplicated, shows the amount of that influence to be but small.

The following contrasted columns present these differences to the eye.

Lower Limestones.
Generally in argillaceous schist, and usually unplicated.

Redhythe, Banffshire.
Matrix gneiss, stratum thin, very highly plicated.
MINERALS.
Talc, in small quantity.
Pyrrhotite, in small quantity.
Biotite, very rare.
Rutile, very rare.

Fordyce.
Matrix gneiss, stratum thick, not plicated.
Talc, rare.

Maisley.
Matrix argill. slate, stratum thick, not plicated.
Antimonite.
Fluor.

Botriphine.
Matrix argill. slate, stratum thick, not plicated.
Kyanite in quartz seams.
Margarodite in quartz seams.

Dufftown.
Matrix argill. slate, stratum thick, not plicated.
Quartz, rare.

Glen Rinnies.
Matrix argill. slate, stratum thick, not plicated.
No minerals.

Candelmore.
Matrix argill. slate, stratum thick, not plicated.
Chlorite, rare.

Alt na Corleachan.
Matrix argill. slate, stratum thick, not plicated.
No minerals.

Carn Ellick.
Matrix argill. slate, stratum thin, not plicated.
No minerals.

Upper Limestones.
In gneissose rocks, and usually highly plicated.

Royndie Bay.
Matrix gneiss, stratum thick, not plicated.
MINERALS.
Mountain leather, rare.
Mountain cork, rare.

Ardonald.
Matrix gneiss, with cover of clay slate, stratum thick, not plicated.
Margarodite, rare.
Kyanite, in quartz seams of, and Grenatite, in the slate.

Limehillock, Grange.
Matrix gneiss, stratum thick, not plicated.
No minerals.

Glen Bucket.
Matrix gneiss, stratum thick, not plicated.
Margarodite.
Pyrite.

Green Hill of Strathdon.
Matrix mica slate, stratum thin, not plicated.
No minerals.

Glen Cairn.
Matrix gneiss, stratum thick, much plicated, dip inverted.
Cinnamon stone abundant.
Idocrase abundant.
Pyrohotite abundant.
Andesine common.
Funkite scarce.
Coccolite common.
Prehnite scarce.
Epidote common.
Wollastonite scarce.
Actynolite scarce.
Lamellar Quartz common.
Pseudo-prehnite common.
Greenovite, very rare.
Rhodonite, very rare.
Diallage, very rare.
Biotite, rare.

Gaulrig.
Matrix argill. slate, stratum thin, not plicated.
Fluor, common.
Steatite, scarce.
Sphene, rare.
Ripidolite, rare.

Boharen.
Matrix argill. slate, stratum thin, not plicated.
Fluor
Hornblende, Kyanite, Staurolite, Garnet, } in matrix, in vicinity.

Upper Limestone.
Muir and Midstrath.
Matrix gneiss, stratum thick, not plicated.
In the limestone.
Fluor.
Graphite.
Sphene.
Malacolite.
Quartz.
Pyrrhotite.
In the Matrix.
White Orthoclase.
Lepidomelane.
Apatite.
Apatite, scarce.
Calcite crystallised, scarce.
Lepidomelane, in matrix.
Scapolite ? ?
Pyrite, very rare.

Crathie.
Matrix gneiss, stratum thick, contorted.
Hornblende and Actynolite.
Sahlite and Coccolite.
Wollastonite.
Prehnite.
Grossular.
Garnet, abundant.
Greenovite.
Idocrase, abundant.
Pyrrhotite.
Pyrite.
Andesine.
Fatty Quartz.
Biotite.
Fluor.

Froster Hill.
Matrix gneiss, stratum thick, plicated.
Augite.
Actynolite.
Pyrrhotite.
Pyrite.
Andesine.
Biotite.
Talc.
Sphene.
Chlorite.

Shinness, Sutherland.
Matrix gneiss, stratum thick, moderately plicated.
Malacolite, abundant.
Sahlite, abundant.
Actynolite, scarce.
Biotite ?
Sphene, scarce.
Molybdenite, very rare.
Apatite, rare.
Pyrrhotite, rare.
Tremolite, rare.
Lepidomelane
Orthoclase
Lepidomelane in matrix.

At the conclusion of the meeting Mr. Dudgeon, who has been Professor Heddle's confrère in many of his wanderings, exhibited specimens of several of the more interesting minerals collected by them: these had been gathered from localities ranging from Unst in Shetland to Lackentyre in Dumfries; from Ben Capval in Harris, in the west, to the Black Dog Rock in the east. They embraced seventeen species new to Scotland, while Dr. Heddle's analytical labours gave promise of some seven new species.

II.—*On the Critical Point in the Consolidation of Granitic Rocks,*

By H. C. Sorby, F.R.S., President of the Royal Microscopical Society, &c., President.

Read September 6th, 1876.

IN carefully reviewing the various facts which I have been able to collect since the publication of my paper on the Microscopical Structure of Crystals,* I have been led to believe that many peculiarities in the structure of granitic rocks may be explained by a principle, which, as far as I am aware, has not hitherto attracted attention. It appears to me extremely probable that the critical point in the consolidation of granitic rocks is very closely connected with the critical temperature at which highly heated and compressed steam would condense into an equal volume of highly heated and expanded liquid water.

As I pointed out in the paper already mentioned, rocks melted under great pressure probably contain water either dissolved as a gas in a liquid, or in the state of a fused hydrate. On cooling down to a lower temperature, the crystallizing out of anhydrous minerals would almost necessarily set free this previously combined water. As long as the temperature was above the critical point it would necessarily remain more or less disseminated in the rock as highly compressed steam, but as soon as the temperature fell below the critical point, it would condense into highly expanded liquid water. Unfortunately, the temperature at which this occurs is only imperfectly known, and I fear it would be very difficult to determine it accurately, on account of the very intense action of such highly heated water on glass. The only determination of this temperature that I am acquainted with is that of Cagniard de La Tour†

* Quart. Journ. Geol. Soc. 1858, Vol. XIV., pp. 453—500.

† Ann de Chimie, 1822, t. XXI., p. 127 and 178; t. XXII., p. 410.

who found that water expands to nearly four times its volume and passes into an equal volume of highly compressed steam at about the melting point of Zinc, which, according to Daniel, is 412° C.; that is to say, at what would be a dull red heat visible in the dark.

As long as the temperature was higher than this, the solvent action of water could not be brought into play, since earthy substances and alkaline salts could not be dissolved in steam; but as soon as it condensed into a liquid, the solvent power of the ater would be very great, as shown by its intense action on glass. Amongst other effects, it would at once dissolve any alkaline chlorides that might be present, so as to form a highly saturated solution. Now all these theoretical deductions agree most remarkably well with the microscopical structure of a very interesting granitic rock from Ponza, the exact history of which I do not know, but am strongly inclined to believe that it is a portion of an ejected block, consolidated at a great depth; and did not form part of a lava flow.

As I pointed out long ago, in the paper already cited, the minerals of ejected blocks and the quartz of granite contain many true gas cavities, as though, besides water, gas was present during the crystallization of the minerals, and was caught up in them as well as liquid water. Very often also, we can see that in those cases where the gas cavities occur, the vacuities in the fluid-cavities are frequently of variable relative size, as though a variable amount of gas was caught up along with the water. This fact, known to me and described long ago, has since been alluded to by Mr. Phillips and Mr. Allport, as though I had overlooked it. I showed that the fluid cavities often had the same character as those in artificial crystals formed at a heat of boiling water near the surface, which catch up variable amounts of water and air. It is a character of considerable importance, and serves to distinguish at once crystals formed under such circumstances from those deposited in the midst of a solution quite free from contact with any gas. Thus for example, in many granites we find true gas cavities, and fluid cavities with a variable abnormal amount of included gas, whilst the quartz in the extremely coarse-grained granite veins at Rubislaw, near Aberdeen, contains no gas cavities, and the vacuities in the fluid cavities are of almost absolutely uniform relative size, as is also the case in that of some simple quartz veins. I may, however, here say that the very great variation in the relative amount of water

and liquid carbonic acid in the cavities, clearly proves that very great changes in the surrounding circumstances sometimes took place, even during the growth of one single crystal; and there is good reason to suspect that there may often have been considerable variations in temperature and pressure, as well as in the relative amount of water and gas.

This difference is still more marked in the case of the different minerals in the curious granitic rock from Ponza already mentioned. The felspar contains many gas cavities, but also many with a small amount of water. It is very difficult to accurately determine the exact relative volume of this liquid, but in the most characteristic cases it appears to be not far from about $\frac{1}{4}$ or $\frac{1}{5}$ of the volume of the entire cavity. If so, the explanation of the origin of such fluid cavities is very simple. According to Cagniard de La Tour's experiments, highly compressed steam heated to a temperature somewhat above the critical point, if caught up in growing crystals, would finally condense and contract so as to give rise to just such cavities as occur in the felspar. In support of this conclusion, it may be said that very few, if any, of the cavities in the felspar contain crystals of the alkaline chlorides, which occur in large amount in the cavities of the quartz, so that there is every reason to conclude that the felspar caught up *steam*, but the quartz *liquid water* saturated with soluble salts. In some parts of the quartz occur gas cavities, but in those parts of the crystals which are more or less free from them, the relative size of the vacuities is sufficiently uniform to enable us to form some idea of the true temperature. There may be, and probably is, some variation, perhaps from about ·5 to ·3, but this may be only apparent, and due to those irregularities in the form of the bubbles and the cavity which cannot be seen when we can only examine a cavity in one line of vision. Probably ·4 is as good an approximation as we can make to the relative size of the vacuity as compared to the liquid, and if so, in accordance with the method of calculation adopted in my paper on the structure of crystals, the temperature must have been about 425° C. Considering all the sources of uncertainty this agrees very well with the temperature of the critical point of water. At all events, the facts seem to show that the quartz was mainly, if not entirely, formed when the temperature of the rock had fallen *just below the critical point of water*, that is to say that it began to crystallize as soon as the partially melted mass could be exposed to the *solvent* action of *liquid* water. In support

of this conclusion, I would say that the cavities in the quartz contain a most unusually large relative quantity of the crystals of alkaline chlorides. Perhaps their bulk is very nearly equal to that of the water, so that for solution the temperature must necessarily have been about as high as that indicated by the size of the vacuities, the one fact thus confirming the conclusion derived from the other.

It would extend this paper to a most undesirable length to enter into the discussion of a considerable number of physical questions connected with this subject, and I must, therefore, confine myself chiefly to general deductions. At all events, in the case of this Ponza granite the facts seem to shew that the greater part of the felspar crystallized when the temperature was above the critical point of water, when it could not act as a solvent; but the greater part of the quartz crystallized when the temperature was below the critical point, so that the water could act as a solvent. As soon as this occurred it would become rapidly saturated with the alkaline chlorides and any other easily soluble salts, and have a most important influence on subsequent changes in the rocks. My own experiments at only moderate high temperatures, and those of Daubrée,* prove that the action of only a small quantity of water at such an elevated temperature as 400° C, is most energetic on artificial glasses, and amongst other things does actually give rise to crystals of quartz. Now, though some of the trachytes of Iceland contain quartz with glass cavities, thus proving that in some cases quartz may crystallize out from a stony mixture in a state of true igneous fusion, yet this is an exceptional circumstance. Taking everything into consideration, it seems more probable that by far the larger part of the quartz in granitic rocks was set free and crystallized through the action of the liquid water, when the temperature had fallen below the critical point, *i.e.*, at a temperature of a dull red heat just visible in the dark. The exact temperature may have varied considerably, since, if the pressure were not sufficiently great, the water might remain in the form of steam until the rock had cooled somewhat more. This would easily explain why the temperature indicated by another quartziferous rock from Ponza, more allied to trachyte than to granite, and very analagous to some of the least granitic elvans of Cornwall, is only about 361° C. This closely corresponds with the mean temperature deduced from the fluid

* Annales des Mines, 5e livraison, 1857.

cavities in the ejected blocks of Somma, which varies from about 340° to 380° in different minerals; or at all events, in the different cases which have come under my observation. As Scheerer has shewn, the properties of pyrognomic minerals prove that many granite rocks cannot have consolidated at a materially higher temperature. All these facts therefore strongly point to the extremely probable conclusion that the critical point in the formation of granitic and other allied rocks was most intimately connected with the critical point of water; and, if so, we have a true and definite physical cause for the production of most important chemical and crystalline changes, at the temperature indicated by a variety of entirely independent physical and chemical phenomena.

III.—*Remarks on the "Principle of least paste, as regulating the Crystallization of Fused Rocks."*

By the Rev. Samuel Haughton, F.R.S., &c.,
Vice-President.

I HAVE been lately examining in conjunction with Prof. Hull a a large series of lavas from Vesuvius, which were collected by Prof. Guiscardi, of the University of Naples, with a view of determining whether, in the space of 300 years, any difference had occurred in the composition of the lava flow. In the course of this investigation a much more important question arose, viz.:— What is the proportion of each mineral present in the lava, and why does that proportion exist?

The rock is composed of *unknown* quantities of nine minerals, of *known* composition viz.: Leucite, Plagioclase, Magnetite, Olivine, Augite, Hornblende, Mica, Nepheline, and Sodalite, together with an *unknown* quantity of a paste of *unknown* composition; from which it is easy to shew that the unknown quantities exceed the number of equations; and consequently, the discussion of the composition of the rock belongs to a branch of the Indeterminate Analysis.

If we attempt to make up as large a percentage of the rock as possible by means of the nine observed minerals, we soon find that the silica, lime, and protoxides, are in excess, and that probably the paste is simply a silicate of lime and iron.

Notwithstanding the apparent difficulty in finding which of the many possible solutions of our system of indeterminate equations is the nearest to the truth, we can, as I think, approach very near the actual solution in nature by the aid of the following principle: "Of the numerous solutions possible that one will occur in nature which involves the largest amount of Definite Minerals and the least amount of Indefinite Paste."

There are a certain number of forces tending to unite the elements into definite combinations as distinct minerals, and the tendency to form such minerals must be greater than that which forms the indefinite paste, so that the affinities of the elements composing the paste are less than those of any definite mineral in the rocks; and thus it will happen (by the principal of "least action") that that particular combination will occur which makes the definite minerals a maximum, and the paste a minimum.*

*The subject is fully treated in the 'Transactions of the Royal Irish Academy.' Vol. XXVI. March, 1876.

IV.—*Some Notes from an Old Catalogue of Minerals.*

By A. H. Church, M.A.

Read September 6th, 1876.

A MS. Catalogue of Minerals by the Comte de Bournon has lately come into my possession. From internal evidence the date of the volume may be fixed at 1811—three years after the publication of the Count's Traité de Minéralogié. The collection of minerals described in this catalogue was made for the Government of Brazil; if the collection still exists, a careful comparison of some of the specimens in it with their descriptions in the catalogue would clear up some obscure points and lead to useful results. Without this aid to a clear understanding of Bournon's descriptions, many interesting facts may be gathered from the manuscript in question. It is, however, a voluminous work extending over 356 pages, and illustrated with a large number of careful drawings of crystalline forms. The author was a very laborious compiler of catalogues. One of these, known to the present writer, is still in existence in the Town Hall of Devonport, along with the magnificent collection of minerals (the St. Aubyn collection) to which it refers. A few notes on the Brazilian catalogue may not be without interest.

Bournon wrote several papers on Cornish minerals, which were published in the Philosophical Transactions. He clearly discriminated between the several arseniates of copper. In speaking of the species now known as liroconite, he is careful to describe its association with cuprite, copper pyrites, metallic copper, &c.; also its variations of colour between a fine blue and a "beau vert-dragon." His second species is "cuivre arseniaté lamelliforme," the chalcophyllite of recent authors. In one specimen of this arseniate he describes its association with pharmocosiderite. Next in order comes olivenite, the fibrous and octahedral forms of which Bournon rightly considered as belonging to one species. But he makes a distinction between some forms of the fibrous arseniate and others. Some, he says, contain more water than olivenite; to these

he gives the name "cuivre hydro-arseniate," including under this term the mamillated wood-copper. Recent analyses show no higher proportions of water in this so-called species of Bournon: thus the *doubt* about its distinctness which the Count expressed in a note in the MS. before us is confirmed. Under the name of "Cuivre et Fer arseniaté," Bournon describes a pale blue mineral of great rarity, accompanied by olivenite, mispickel, pharmacosiderite, &c. We feel that its identification with any recognised species of arseniate is uncertain.*

One of the richest sections of the Brazilian collection was that of the different varieties of spinel: it included no less than 874 specimens. Inserted in the catalogue are 32 figures illustrating modified and twinned crystals of this species. Some of the forms illustrated are by no means common; a few do not appear to have been recorded. Figs. 1 to 4, Plate 2, reproduce a few of these forms which are not given by either Brooke and Miller or Dana.

The specimens of corundum illustrated in the catalogue must have been very important and interesting, if one may judge from the 23 figures introduced into the text. At the end of the description of this mineral species is a good account of the phenomenon of chatoyancy as exhibited in the cats-eye variety of corundum; this account is accompanied by an explanatory diagram.

A thorough examination of this Brazilian Catalogue should be made, meanwhile the indications of its contents above given may provoke some inquiry as to the present *locale* of the collection to which it refers.

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* May not this be the Scorodite which was afterwards called Martial Arseniate of Copper by Phillips? J.H.C.

V.—*Manganese in the Sea.*

By A. H. Church, M.A.

Communicated August, 1876.

TO the geologist, the mineralogist and the chemist, two of the observations made during the voyage of the Challenger are of especial interest. One of these observations is the occurrence over vast areas of the deep sea bottom of a peculiar red clay, containing silica, peroxide of iron, and alumina. The other discovery to which I refer has been described by Sir Wyville Thomson as the occurrence throughout this red clay of nodules of "nearly pure peroxide of manganese." To these nodules, as well as to the red clay, an organic origin has been assigned. But the immediate source of so much manganese is hard to find, for this element is by no means an abundant constituent of animal or vegetable organisms. The difficulty is, however, somewhat lessened when the manganese nodules are submitted to a more minute chemical examination. From two correspondents I have received an ample supply of these curious concretions, accompanied by a suggestion that they should be submitted to chemical analysis.

The specimens were from two localities in the Pacific. In the centre of one of the nodules was a core of indurated red clay: in two other specimens analysed, fragments of pumice occupied the middle of the concretion. All the specimens were almost homogeneous, so far as ordinary chemical and physical tests were capable of showing.

The material had, however, been deposited in several concentric layers, which, in some part of the nodules could be successively removed. In some of the specimens (which were *not* submitted to analysis) a very fine layer of a paler substance separated the blackish manganiferous layers from each other.

The following are the chief characters of the nodules:—Hardness 3.5, Specific gravity 1.89. Colour brownish black: streak somewhat shining: powder, between blackish brown and clove-brown: fragile; fracture, rough conchoidal.

In the closed tube this mineral gives out much water having a slightly alkaline reaction. Before the blowpipe it contracts, becomes black, and fuses at the edges. With hydrochloric acid chlorine is evolved, and silica separated as the mineral dissolves.

Qualitative analysis shows that the powdered nodules, from which any clay cores, &c., have been carefully removed, contain a small quantity of the salts of sea-water. Cold water removed from a powdered sample just ·71 per cent. of chlorine in the form of chlorides of sodium, magnesium, &c. The mineral used for the subsequent quantitative determinations was not, however, thus washed, but had been merely powdered and exposed for an hour or two to the air. The following are the numerical details of my analyses.

I.—·5295 gram lost ·13 gram H_2O in vacuo over sulphuric acid.

The above vacuum-dried mineral gave ·053 gram H_2O when heated in a current of air, the water being weighed in a chloride-of-calcium tube. The platinum boat lost ·01 gram more than the chloride of calcium absorbed, showing the original state of peroxidation of the manganese: a slight yellowish sublimate occurred in this experiment.

II.—·412 gram of mineral (from a large nodule) lost .107 gram in vacuo, and .047 gram at a red heat. These figures correspond, respectively, to 25.97 and 11.31 per cent. of water.

III.—·301 gram gave ·07 gram Fe_2O_3 and Al_2O_3.
,, ,, ·0795 ,, Mn_3O_4
,, ,, ·0315 ,, SiO_2
IV.—·3015 ,, ·0705 ,, Fe_2O_3 and Al_2O_3
,, ,, ·08 ,, Mn_3O_4
,, ,, ·031 ,, SiO_2
V.—·5295 ,, ·0175 ,, Al_2O_3

From the above results, (excluding analysis II), the following mean percentages of the chief constituents of the "manganese" nodules are calculated:—

	in 100 parts.
Water lost *in vacuo*	24·55
Water retained at 100°C but evolved at a red heat ..	10·00
Manganese dioxide	30·22
Ferric oxide	20·02

Alumina	3·30
Silica	10·37
Chlorine	·71
Mg, Ca, Cu, Na, Cl, P_2O_5 &c.	·83
	100·00

It would be rash to assume from the above data, which represent the average amount of the several constituents of a few only of these nodules, that we have here a new and definite mineral. If, however, many other analyses of numerous homogeneous specimens from diverse localities of the deep sea bottom should yield the same or nearly-related results, then the singularity of the mode of formation, of the occurrence, and of the composition of these concretions should constitute no bar to their recognition as a distinct mineral species under such a name as *Pelagite*. It would at present be impossible to assign a formula to this 'pelagite,' but the analyses I have quoted correspond pretty closely to a compound expressed by the formula 2 MnO_2, Fe_2O_3, SiO_2, 12 aq. It would appear probable that the red clay, which is so constantly found associated with these black nodules, is itself a hydrated silicate of alumina and ferric oxide.

I stated at the commencement of the present note that the black nodules have been invariably described as nearly pure black oxide of manganese. I have examined 11 characteristic specimens or fragments—some large and some small, but have not yet met with any specimens notably free from iron &c. than those analysed above. Yet these nodules, black grains, concretions, are always described as "peroxide of manganese," (Proc. Roy. Soc. xxiii. p. 45. Nov. 1874). In the address by Sir Wyville Thomson at Glasgow (11 Sept. 1876. See Report, revised by the author, in "Nature," vol. xiv, p. 492) he uses the same expression, "nearly pure peroxide of manganese." As this passage from his address contains Sir Wyville Thomson's latest description of these black nodules, I quote it here *in extenso*.

"Over the whole bottom of the Pacific, or a very large part of it, we find red clay, and particularly in the North Pacific, where there is a great depth of water. The red clay has all through it nodules, which vary from the size of sago, or a canary seed to the size of a child's head or an orange, composed of nearly pure peroxide of manganese. These are found in enormous quantity. The trawl sent down to the bottom in those regions brings up masses of concretions, much resembling lumps of the mineral known as *wad*, almost all of which contain as a kernel in the interior, a fish's tooth, or a little bit of sponge, or some fossil

of some kind, which has formed the nucleus round which the manganese has accumulated. This is altogether a most peculiar and novel observation. In the Atlantic, and all over the bottom of the sea we find manganese in minute bits, but in the North Pacific particularly, these pieces are in very great quantity and attain a large size. This is a phenomenon which we are as yet unable to explain, and I do not know that there is any analogous instance in any of the older formations."

Postscript, October 6, 1876.—So far was the above account of my results written when I received No. 170 of the Proc. Roy. Society containing the "Report from the Challenger." From Mr. Buchanan's notice of the class of black oceanic nodules which form the subject of the present note, it is evident that he has fully recognised their complex composition. He gives no quantitative results at present, but promises further inquiry in this direction. Meanwhile, the present communication may serve as a slight corrective to the wide-spread statement copied into newspapers and periodicals of all kinds, English and Foreign, that all these dark-coloured oceanic concretions consist almost exclusively of pure black oxide of manganese. And, further, it may prove of some slight use and interest as affording an independent analysis for comparison with the authoritative conclusions which are promised by Mr. Buchanan.

VI.—*Note on a mineral from New South Wales, presumed to be Laumontite.*

By Archibald Liversidge, F.G.S., &c., Professor of Geology in the University of Sydney.

Read September 6th, 1876.

THIS mineral was first observed by Mr. C. E. Wilkinson, the Government Geologist, and obtained by him from a cutting on the Bathurst Road, near the Cox River.

It occurs as small irregular veins, of a pleasing salmon colour, running through a soft bluish grey shale, the veins together with the included plates of shale are sometimes six inches thick, but usually smaller; the actual veins of the mineral itself being only about one eighth of an inch thick. Some difficulty was on this account experienced in obtaining sufficient of the sample pure enough for analysis.

The mineral appears to be partially crystallized, nothing definite could be made out, but some of the confused crystals had somewhat the appearance of rhombic prisms. It apparently cleaves parallel to the long axis, and lies perfectly at right angles to it.

Sp. gr., about 2·5. Hardness, about 2·5, can be crushed by the thumb nail, being very tender. Streak, pink, but paler than the mineral itself.

Heated in the closed tube it gives off water, and at a red heat becomes grey, but re-acquires a pink colour on cooling, which is rather paler than the original colour. On platinum foil, when strongly heated, it fuses to a whitish mass. Does not impart any distinctive tint to outer flame. With nitrate of cobalt gives a blue colour. Soluble in HCl with separation of much gelatinous silica.

Analysis.

Combined water	12·646
Alumina and traces of iron	22·833
Silica	53·266
Lime	11·000
Magnesia	·479
	100·224

VII.—*Note on the occurrence of Achroite at Rock Hill, in the parish of St. Austell, Cornwall, and on the black tourmaline of the same locality.*

By J. H. Collins, F.G.S.

Read September 6th, 1876.

As black tourmaline or "schorl" is one of the most abundant and widely distributed of the minerals of the West of England, it is perhaps somewhat remarkable that the variously colored and colorless varieties are extremely rare both in Cornwall and Devon. Among recorded localities, I am not aware that the green or brownish green *Zeuxite* has occurred, except at Huel Unity, Carn Marth, and Great Work Mine, in Cornwall, and near Okehampton in Devon, while the colorless variety *Achroite* has only been observed at Roscommon Cliffs, in St. Just; and the red, blue, and yellow varieties are so far quite unknown in the two western counties. I have lately been examining a number of specimens obtained in a large open tin working at Rock Hill, in the parish of St. Austell, Cornwall, in 1871 and 1872, and among them I have found several specimens of Achroite. When I first obtained them I thought they were quartz, and, indeed, I referred to them as such in a paper which I read to the Miners' Association of Cornwall and Devon, in 1872,* but I am now satisfied that they are colorless tourmaline or Achroite.

The mineral occurs in long flexible glistening prisms, which are from $\frac{1}{500}$th to $\frac{1}{2000}$th of an inch in thickness, perhaps averaging $\frac{1}{1000}$th of an inch. Some are $\frac{1}{4}$ of an inch long or even more.

Viewed by ordinary transmitted light they are all perfectly colorless and transparent, but when viewed by polarized light the thicker ones are occasionally colored. Being so extremely thin, I have not been able to get a cross-section, but the prisms appear to be 6-sided in some instances. Very few terminations can be seen, but I have observed some which appear like fig. 8, Pl. 2, the pyramid being much less acute than in quartz, very often the crystals form divergent groups as in fig. 9.

* Rep. Min. Assoc. Corn. and Dev., 1872.

The mineral occurs in such very small quantity that I have not been able to get enough for a complete analysis, but I have detected silica, fluorine, and boron by the aid of the blowpipe, which, coupled with the form of the crystals and their constant association with ordinary black tourmaline, (as shewn in the specimens exhibited,) leaves little doubt that it is really Achroite.

The mode of occurrence is of considerable interest, and I propose to describe it somewhat in detail.*

Rock Hill forms part the Hensbarrow granite mass, and there are some considerable tin workings on its eastern side.

The main excavation is of a nearly circular form, about 100 feet in diameter, and varying from 40 to 70 feet deep. Opening from this on the east side, is another excavation about 100 feet long, 30 feet wide, and 20 feet deep. The main mass of the hill consists of granite, the felspar of which is, in parts, completely decomposed into kaolin or china clay. The main pit itself is crossed by a very large schorlaceous tin lode, whose bearing is nearly N.E., and this consists chiefly of schorl and quartz, but contains on an average about 4 to 8 lbs. of oxide of tin per ton of rock. It is crossed at a very acute angle by a cross-vein of very similar mineral character, which, like the lode just described, contains a little tin, at any rate near the point of intersection. The cross-vein bears nearly north, and appears to be of somewhat more recent formation than the tin lode, as it "heaves" or faults it a little.

The lode dips or "underlies" to the W. of N. about 2 feet in the fathom; the cross-course underlies East at about the same rate. Besides the lode and cross-course, a great number of smaller lodes and branches traverse the pit in every direction. Many of them come together near the centre of the pit, a little east of the point of intersection of the two larger veins, so as to form a kind of knot of quartz and schorl with a little oxide of tin. At some of the intersections rich masses of tin ore occur, some containing 50 or even 60 per cent. of tin oxide. From one such intersection, about 1869, in the deepest part of the pit, 17 tons of oxide of tin was obtained.

To the chemical geologist this network of hard schorlaceous bands occurring in the decomposed granite is of great interest, for it affords evidence of pseudomorphism on a large scale. The bands present

* As the mine is now stopped, specimens should be looked for on the rubbish heaps.

much more the appearance of veins of segregation than of true fissure veins, although a fissure has probably been the determining cause of each one. Sometimes the fissures appear to have been re-opened at different and successive epochs as in so many other districts, but the schorlaceous and stanniferous matter which has passed into these fissures not finding room enough has, so to speak, overflowed, and saturated, the surrounding rocks.

The complex lodes so formed, appear to have contained at one time large crystals of felspar like the decomposed granite of the immediate neighbourhood. These crystals have been in every case changed. In the "country" they now consist of kaolin; in the lodes the felspar has usually been replaced by quartz, frequently by schorl, and occasionally by oxide of tin, or by all three minerals together. In some instances the cavities caused by the removal of the felspar have been only partially filled, when they are seen to be lined with the replacing material in the state of crystals projecting inwards from the sides, or in a pasty or pulverulent form.

It is usually in such partially filled cavities that the Achroite occurs as shewn in the specimens on the table, while sometimes small cavities in almost pure black or bluish black massive schorl are covered with the same silky looking prisms.* This almost massive schorl forms an interesting object for the microscope, when cut into thin sections.

As to the order of changes some ideas are suggested by the manner of association of the schorl and quartz. Schorl is frequently seen enclosed in quartz, but the reverse has not been observed. In some instances crystals of schorl are found, which are only partially enclosed in the quartz, part remaining free; one such example is illustrated in fig. 10. Moreover, many fissures in the complex masses of schorl rock may be observed, and these are almost always lined with quartz. Some of the fissures are lined with both schorl and quartz, but if so, the quartz is always the later to be deposited, being always found nearest the centre of the fissure. Figs. 5, 6, and 7, illustrate some of the more commonly occuring veins. a. is in each case partially decomposed granite, b. is greisen, c. is schorl,

* The more massive schorl is often accompanied by a bluish mineral, which is semi-transparent. Its nature has not yet been determined.

d. is quartz. We have, I believe, evidence of at least the following series of successive operations, conditions, and changes, in this interesting hill.

1.—Original formation of the granite mass.

2.—Fissuring of the same at two or more distinct epochs; alteration of felspar into kaolin; deposition of schorl, oxide of tin, felspar, and quartz in the fissures; and impregnation of the surrounding country with schorlaceous matter.

3.—Removal of the felspar crystals from some parts of the larger veins leaving open cavities.

4.—Partial filling of these with schorl and oxide of tin.

5.—Completion of the filling of some of them by quartz enclosing the previously deposited schorl and oxide of tin.

6.—Fracturing of the complex schorl rock so formed.

7.—Partial filling of the fissures with a lining of schorl.

8.—Deposition of a secondary lining of quartz.

Correspondence and Abstracts.

ENYSITE.

To the Editor of the Mineralogical Magazine.

This letter was sent to the Editor as a private note, with, at first, no idea of publication.

Sir,—I have this morning (22nd September, 1876) examined *Enysite*, and find it contains (besides what is mentioned in the August number of the Magazine) a slight trace of *lead*, with something giving a brown flame and sublimate, probably a trace of Cadmium. Dr. Foster mentions a white sublimate in his analysis, it is easily seen on Al. plate, with the yellow of PbO, but it was not examined afterwards (as it ought to be) in boric acid. I examined Enysite *quantitatively* for silica by my method as modified by Prof. Stokes, and first got 1·9 %, then 2·0 %. I only tried it twice.

There certainly does not appear to to be any *soda* in this mineral, as may be easily proved by dissolving some of its powder in boric acid, the green flame of which (made blue-green by Cu from the mineral) is unaltered. If *now* you add $1^{mgr.}$ of sodium carbonate, the flame becomes distinctly *yellow*.* There appears, however (by vesiculation and breathing) to be a trace of potash.

There seems *very* little lime, I get less even than your analysis gives; but I have not completed my quantitative method for lime yet. There certainly is *some*. W. A. ROSS.

Blowpipe Analysis of Henwoodite, by W. A. Ross.
(*Chem. News*, Oct. 13th, 1876).

1. *Appearance.*—Rounded aggregation of lenticular crystals; pale green-blue.
2. *Al. plate, OP.*—Color changed to chocolate-brown.
   - *a.*—Adhered to Magnet, (due to particles of oxide of iron, adhering to crystals).
   - *b.*—Green pyrochrome; might be due to copper, molybdenum, barium, phosphoric acid, &c., no sublimate; no sulphur re-action.
3. *Crushed* (2) *treated in OP on bead of boric acid*—Blue green pyrochrome: = copper.
   - *a.*—Streaks of curdy matter heating into opalescence = phosphoric acid or water, see (5).

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* There certainly is soda present in the mineral, as I found by the spectroscope but not in anything like the proportion that would be present in testing by the mode suggested by Major Ross. I found *no* potash by the spectroscopic test.—J.H.C.

b.—White amorphous fragments, black do., with rusty matter all round. White balls=calcium phosphate, one grey ball, one black ball, all opaque. The whole bead interspersed with shining crystalline spots = insol. silica?

4. *Added a fragment of pure lime under OP.*—A large clear ball; pale yellow green, hot; nearly colorless, cold; = Fe O. (A particle of cupric oxide *without iron*, colors a similar ball brilliant chrome green, hot or cold).
5. *Clarified opalescent bead with potassium carbonate and magnesium sulphate.*

   a.—Added fresh boric acid OP. Clear bead became opalescent on cooling = phosphoric acid.
6. *Heated another piece of* (1) *with pure oxide of lead on charcoal mortar on Al. plate.*—Fused with great effervescence to a crystalline mass of plumbic phosphate with minute balls of copper interspersed.*
7. *Heated fresh piece of* (1) *with sodium carbonate on Al. plate in OP.*—Fused to brick red mass = Cu_2O.
8. *Crushed* (7), *boiled in water, acidulated with boric acid.*—Two precipitates, *a* brown, flocculent above; *b* brick red below=Cu_2O
9. *Treated* (8) *in boric acid bead in OP.*—Great opalescence = phosphoric acid (as seen by 5*a*); some opaque white balls, and fragments, two black balls; several clear small crystals = silica.

Remarks.—Presence of alumina or phosphoric acid seen from (3*b*) and (8*a*); of silica from (3*b*) and (9) of lime from the white *balls* which might, however, have been MgO.

Presence of copper so evident that it was unnecessary to use phosphoric acid as a detective.

The minuteness of these details (necessary where a process is described for the first time) makes the analysis appear much longer than it is, but the essential character of the mineral appears in operation (3); what follows is chiefly confirmative.

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* *Note by the author.* Berzelius says (p. 84 Am. Ed.) "The unexpected discovery of phosphoric acid in *Wavellite*, &c., has shown the necessity of a re-agent for this acid. Its known behaviour, in combination with the oxide of lead, induced me to attempt to discover some method of detecting its presence by the help of lead, or the oxide of lead, which, however, did not succeed, except in the case of phosphate of copper."

He is quite right: the crystallization of plumbic phosphate is a very poor test for phosphoric acid, which cannot be detected half so delicately or correctly by any pyrogical method as that above given. I used lead oxide with the view of a metallurgical separation of *copper*, which is beautifully effected this way.—W.A.R.

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